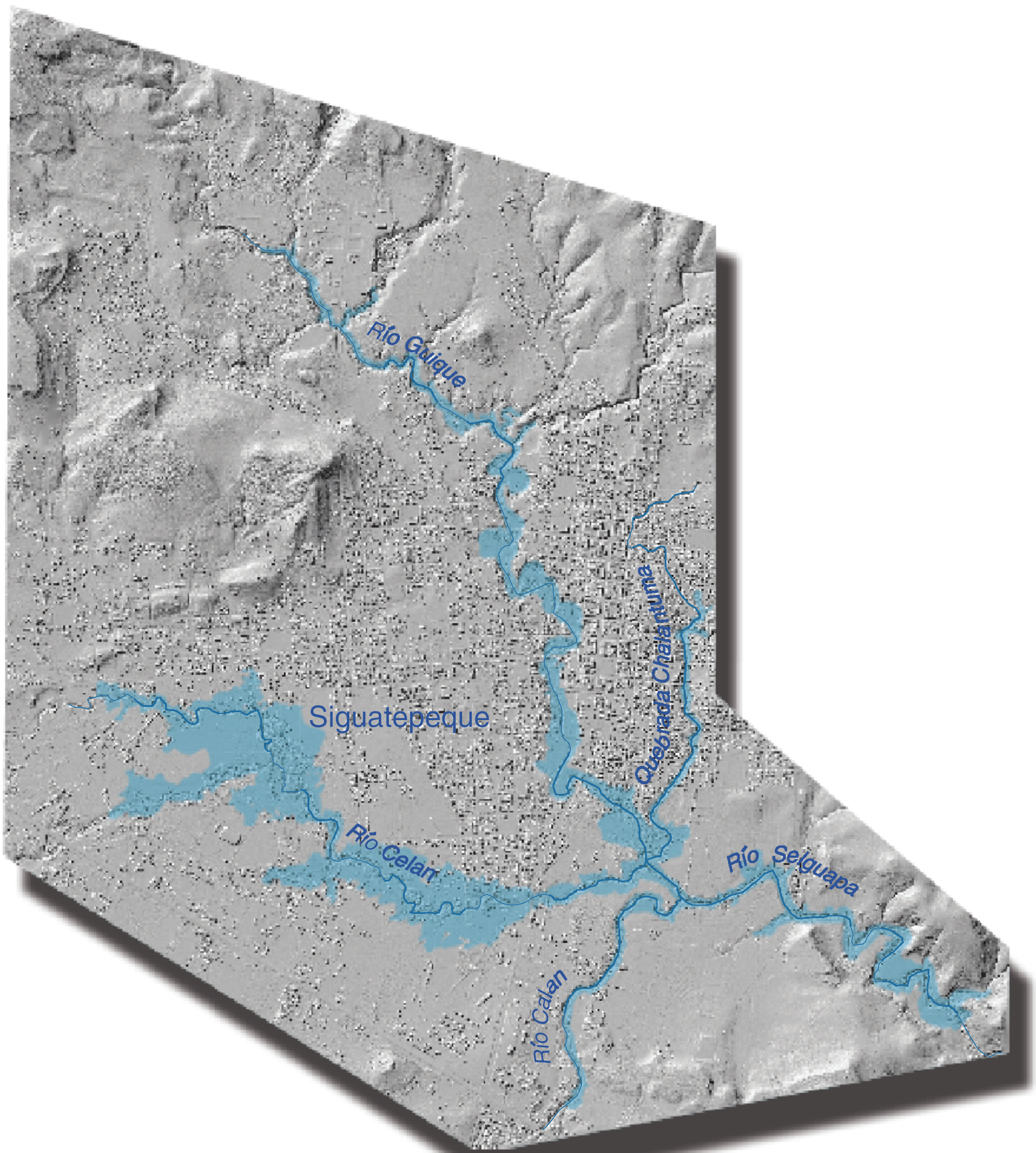
Prepared in cooperation with the U.S Agency for International Development

Fifty-Year Flood-Inundation Maps for Siguatepeque, Honduras

U.S. Geological Survey Open-File Report 02-259



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Fifty-Year Flood-Inundation Maps for Siguatepeque, Honduras

By David L. Kresch, Mark C. Mastin, and Theresa D. Olsen

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 02-259

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U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

Tacoma, Washington
2002

U.S. DEPARTMENT OF THE INTERIOR
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CONVERSION FACTORS AND VERTICAL DATUM

CONVERSION FACTORS

Multiply	By	To obtain
cubic meter per second (m^3/s)	35.31	cubic foot per second
kilometer (km)	0.6214	mile
meter (m)	3.281	foot
millimeter (mm)	0.03937	inch
square kilometer (km^2)	0.3861	square mile

VERTICAL DATUM

Elevation: In this report "elevation" refers to the height, in meters, above the ellipsoid defined by the World Geodetic System of 1984 (WGS 84).

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ABSTRACT

After the devastating floods caused by Hurricane Mitch in 1998, maps of the areas and depths of the 50-year-flood inundation at 15 municipalities in Honduras were prepared as a tool for agencies involved in reconstruction and planning. This report, which is one in a series of 15, presents maps of areas in the municipality of Siguatepeque that would be inundated by 50-year floods on Río Selguapa, Río Guique, Río Celan, Río Calan, and Quebrada Chalantuma. Geographic Information System (GIS) coverages of the flood inundation are available on a computer in the municipality of Siguatepeque as part of the Municipal GIS project and on the Internet at the Flood Hazard Mapping Web page (http://mitchnts1.cr.usgs.gov/projects/floodhazard.html). These coverages allow users to view the flood inundation in much more detail than is possible using the maps in this report.

Water-surface elevations for 50-year-floods on each of the streams studied were computed using HEC-RAS, a one-dimensional, steady-flow, step-backwater computer program. The channel and floodplain cross sections used in HEC-RAS were developed from an airborne light-detection-and-ranging (LIDAR) topographic survey of the area and ground surveys at six bridges.

There are no nearby long-term stream-gaging stations on any of the streams studied; therefore, the 50-year-flood discharges were estimated using a regression equation that relates the 50-year-flood discharge to drainage area and mean annual precipitation. The 50-year-flood discharges estimated for Río Selguapa, Río Guique, Río Celan, Río Calan, and Quebrada Chalantuma are 323, 168, 161, 146, and 90 cubic meters per second, respectively.

INTRODUCTION

In late October 1998, Hurricane Mitch struck the mainland of Honduras, triggering destructive landslides, flooding, and other associated disasters that overwhelmed the country’s resources and ability to quickly rebuild itself. The hurricane produced more than 450 millimeters (mm) of rain in 24 hours in parts of Honduras and caused significant flooding along most rivers in the country. A hurricane of this intensity is a rare event, and Hurricane Mitch is listed as the most deadly hurricane in the Western Hemisphere since the “Great Hurricane” of 1780. However, other destructive hurricanes have hit Honduras in recent history. For example, Hurricane Fifi hit Honduras in September 1974, causing 8,000 deaths (Rappaport and Fernandez-Partagas, 1997).

As part of a relief effort in Central America, the U.S. Agency for International Development (USAID), with help from the U.S. Geological Survey (USGS), developed a program to aid Central America in rebuilding itself. A top priority identified by USAID was the need for reliable flood-hazard maps to help plan the rebuilding of housing and infrastructure in Honduras. The Water Resources Division of the USGS in Washington State, in coordination with the International Water Resources Branch of the USGS, was given the task to develop flood-hazard maps for 15 municipalities in Honduras: Catacamas, Choloma, Choluteca, Comayagua, El Progreso, Juticalpa, La Ceiba, La Lima, Nacaome, Olanchito, Santa Rosa de Aguán, Siguatepeque, Sonaguera, Tegucigalpa, and Tocoa. This report presents and describes the determination of the area and depth of inundation in the municipality of Siguatepeque that would be caused by 50-year floods on Río Selguapa, Río Guique, Río Celan, Río Calan, and Quebrada Chalantuma.

The 50-year flood was used as the target flood in this study because discussions with the USAID and the Honduran Public Works and Transportation Ministry indicated that it was the most common design flood used by planners and engineers working in Honduras. The 50-year flood is one that has a 2-percent chance of being equaled or exceeded in any one year and on average would be equaled or exceeded once every 50 years.

Purpose, Scope, and Methods

This report provides (1) results and summary of the hydrologic analyses to estimate the 50-year-flood discharges used as input to the hydraulic model, (2) results of the hydraulic analysis to estimate the water-surface elevations of the 50-year-flood discharges at cross sections along the stream profiles, and (3) 50-year-flood inundation maps for Siguatepeque showing area and depth of inundation.

The analytical methods used to estimate the 50-year-flood discharges, to calculate the water-surface elevations, and to create the flood-inundation maps are described in a companion report by Mastin (2002). Water-surface elevations along Río Selguapa, Río Guique, Río Celan, Río Calan, and Quebrada Chalantuma were calculated using HEC-RAS, a one-dimensional, steady-flow, step-backwater computer model; and maps of the area and depth of inundation were generated from the water-surface elevations and topographic information.

The channel and floodplain cross sections used in HEC-RAS were developed from an airborne light-detection-and-ranging (LIDAR) topographic survey of Siguatepeque and ground surveys at six bridges. Because of the high cost of obtaining the LIDAR elevation data, the extent of mapping was limited to areas of high population density where flooding is expected to cause the most damage. The findings in this report are based on the condition of the river channels and floodplains on March 10, 2000, when the LIDAR data were collected, and March 19, 2000, when the bridges were surveyed.

Acknowledgments

We acknowledge USAID for funding this project; Jeff Phillips of the USGS for providing data and field support while we were in-country; Roger Bendeck, a Honduran interpreter, for being an indispensable guide, translator, and instrument man during our field trips; and Efrain Aquiles Pereira, the mayor of Siguatepeque, and Hannabel Sierra, the Public Works Director of Siguatepeque, who gave us important local insights into the hydrology of and historical flooding along the streams in Siguatepeque and allowed us access to the streams during our field surveys.

DESCRIPTION OF STUDY AREA

Río Guique, Río Celan, Río Calan, and Quebrada Chalantuma join near the southeast boundary of Siguatepeque to form Río Selguapa (figure 1). The study area includes the channel and floodplains of each of these five streams in the vicinity of Siguatepeque.

The streambed material of the stream reaches studied varies considerably from sand and gravel to cobbles and bedrock. The vegetation on the main channel banks and floodplains also varies considerably, ranging from grass to thick brush and tropical plants.

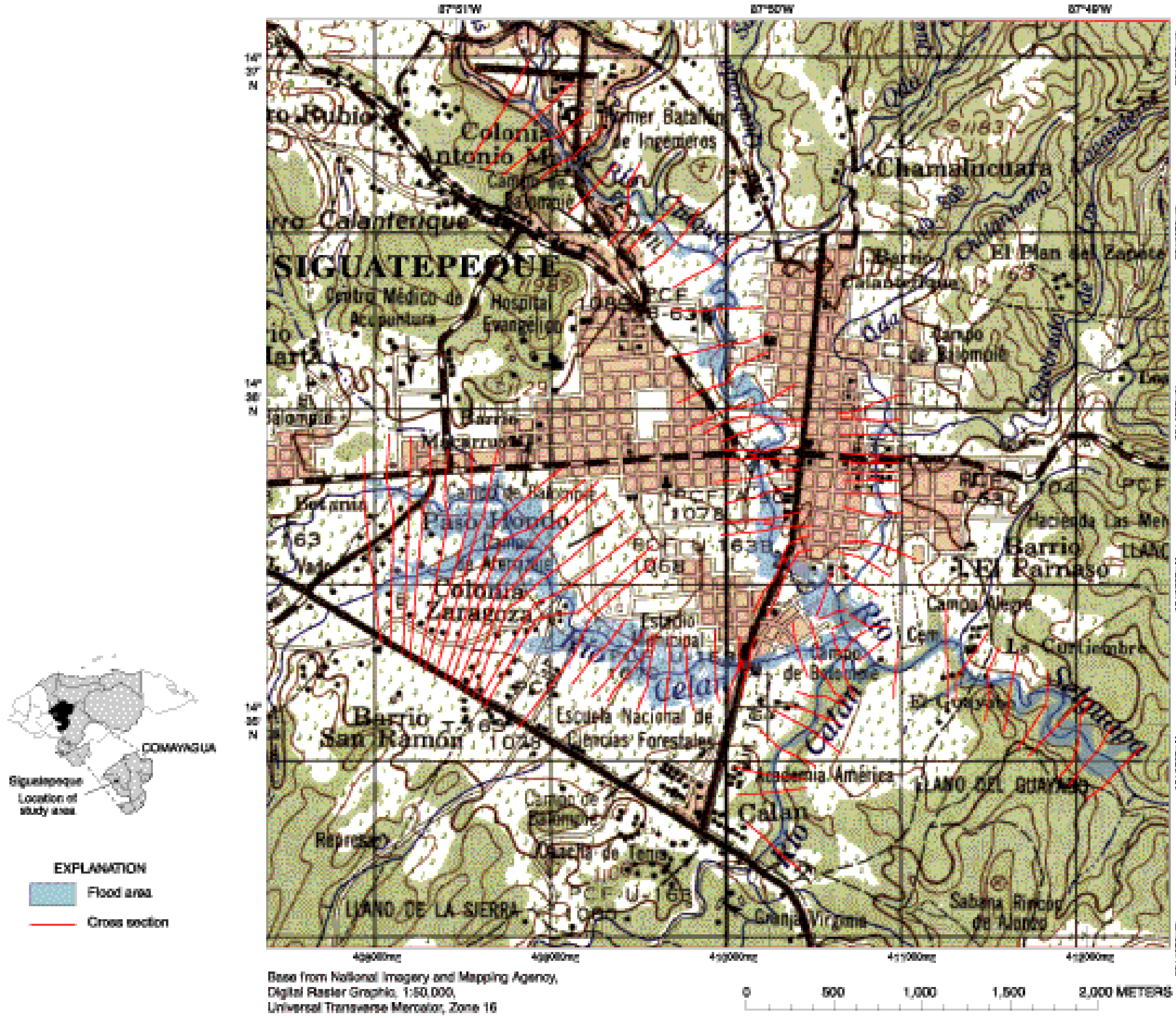

Figure 1. Location of study area and cross sections, and the area of inundation for the 50-year flood on Río Selguapa, Río Guique, Río Celan, Río Calan, and Quebrada Chalantuma at Siguatepeque, Honduras.

FIFTY-YEAR FLOOD DISCHARGE

There are no long-term streamflow records on Río Selguapa, Río Guique, Río Celan, Río Calan, or Quebrada Chalantuma; therefore, the 50-year-flood discharges for these streams were estimated using the following regression equation, which was developed using data from 34 streamflow stations throughout Honduras with more than 10 years of annual peak flow record, that relates the 50-year peak flow with drainage basin area and mean annual precipitation (Mastin, 2002).

$$Q_{50} = 0.0788(DA)^{0.5664}(P)^{0.7693}\ , \qquad (1)$$

where

Q_{50} is the 50-year-flood discharge, in cubic meters per second (m^3/s),

DA is drainage area, in square kilometers (km^2), and

P is mean annual precipitation over the basin, in mm.

The standard error of estimate of equation 1, which is a measure of the scatter of data about the regression equation, is 0.260 log unit, or 65.6 percent. The standard error of prediction, which is a measure of how well the regression equation predicts the 50-year-flood discharge and includes the scatter of the data about the equation plus the error in the regression equation, equals 0.278 log unit, or 71.3 percent

The drainage area of each stream reach studied was calculated using a geographic information system (GIS) program to analyze a digital elevation model (DEM) with a 93-meter cell resolution from the U.S. National Imagery and Mapping Agency (David Stewart, USGS, written commun., 1999). The mean annual precipitation over each stream reach drainage basin was calculated using a GIS program to analyze a digitized map of mean annual precipitation at a scale of 1:2,500,000 (Morales-Canales, 1997–1998, p. 15).

The 50-year-flood discharge that was calculated from regression equation 1 for each stream reach studied and the associated drainage area and mean annual precipitation values used in the calculations are given in table 1.

The sum of the estimated 50-year-flood discharges for the four Río Selguapa tributary streams (565 m^3/s) is considerably larger than the 50-year-flood discharge estimated for Río Selguapa (323 m^3/s), which is reasonable because the 50-year floods on the tributary streams are not likely to occur simultaneously.

Table 1. Drainage area, mean annual precipitation, and estimated discharge for the 50-year flood for Río Selguapa, Río Guique, Río Celan, Río Calan, and Quebrada Chalantuma at Siguatepeque, Honduras

[**Abbreviations**: km^2, square kilometers; mm, millimeters; m^3/s, cubic meters per second]

Stream reach	Drainage area (km^2)	Mean annual precipitation (mm)	50-year-flood discharge (m^3/s)
Río Selguapa	139	1,315	323
Río Guique	40.3	1,398	168
Río Celan	42.0	1,283	161
Río Calan	37.7	1,217	146
Quebrada Chalantuma	13.2	1,420	90

WATER-SURFACE PROFILES OF THE 50-YEAR FLOOD

Once a 50-year flood discharge has been estimated, a profile of water-surface elevations along the course of the river can be estimated for the 50-year flood with a step-backwater model, and later used to generate the flood-inundation maps. The U.S. Army Corps of Engineers HEC-RAS modeling system was used for step-backwater modeling. HEC-RAS is a one-dimensional, steady-flow model for computing water-surface profiles in open channels, through bridge openings, and over roads. The basic required inputs to the model are stream discharge, cross sections (geometry) of the stream channels and floodplains perpendicular to the direction of flow, bridge geometry, Manning's roughness coefficients (*n* values) for each cross section, and boundary conditions (U.S. Army Corps of Engineers, 1998).

Cross-section geometry was obtained from a high-resolution DEM created from an airborne LIDAR survey. The LIDAR survey was conducted by personnel from the University of Texas. A fixed-wing aircraft with the LIDAR instrumentation and a precise global positioning system (GPS) flew over the study area on March 10, 2000. The relative accuracy of the LIDAR data was determined by comparing LIDAR elevations with GPS ground-surveyed elevations at 1,252 points in the Siguatepeque study area. The mean difference between the two sets of elevations is -0.154 meter, and the standard deviation of the differences is 0.098 meter. The LIDAR data were filtered to remove vegetation while retaining the buildings to create a "bare earth" elevation representation of the floodplain. The LIDAR data were processed into a GIS (Arc/Info™) GRID raster coverage of elevations at a 1.5-meter cell resolution. The coverage was then processed into a triangular irregular network (TIN) GIS coverage. Cross sections of elevation data oriented across the floodplain perpendicular to the expected flow directions of the 50-year-flood discharges (figure 1) were obtained from the TIN using HEC-GeoRAS, a pre- and post-processing GIS program designed for HEC-RAS (U.S. Army Corps of Engineers, 2000). The underwater portions of the cross sections cannot be seen by the LIDAR system. However, because the LIDAR surveys were conducted during a period of extremely low flows, the underwater portions were assumed to be insignificant in comparison with the cross-sectional areas of flow during a 50-year flood; therefore, they were not included in the model.

Part of the Río Celan drainage upstream of cross section 2.777 is contributed by a tributary stream. However, rather than model these stream reaches individually, they were treated as a single reach because a 50-year-flood would inundate both stream channels and the floodplain area between them for much of the reach studied upstream of their confluence.

There were too many bridges across the stream reaches studied in Siguatepeque to be able to survey all of them during the time allotted for field work. Consequently, the focus of the field surveys was primarily on arterial bridge crossings. The only two bridge crossings that were completely field surveyed were on Río Guique and Río Celan where they cross the main north-south road through Siguatepeque. These bridges, which are located at station 0.555 on Río Guique and at station 0.661 on Río Celan, were surveyed on March 19, 2000. In addition, the geometry of four other bridges was measured on this day. Two of these, the bridge at station 1.497 on Río Guique and the bridge at station 1.217 on Quebrada Chalantuma, are on the main east-west road through Siguatepeque. The other two bridges, at station 1.076 on Río Guique and at station 1.119 on Quebrada Chalantuma, are at small neighborhood street crossings. The geometry measured at the four bridges, which was referenced to the bridge decks, was tied to survey datum by means of LIDAR-determined elevations of the bridge decks. Because it is unknown if any of the unsurveyed bridges would constrict flood flows, the water-surface elevations computed by the model may be too low upstream of them. Regular cross sections were placed near many of the bridges that were not surveyed to at least approximate the amount of natural constriction that might be present in the stream reaches where the bridges are located.

Most hydraulic calculations of flow in channels and overbank areas require an estimate of flow resistance, which is generally expressed as Manning's roughness coefficient, *n*. The effect that roughness coefficients have on water-surface profiles is that as the *n* value is increased, the resistance to flow increases also, which results in higher water-surface elevations. Roughness coefficients (Manning's *n*) for the stream reaches studied were estimated from digital photographs taken during the field visit of the study area on March 19, 2000, and from computer displays of shaded-relief images of the LIDAR-derived DEM before any vegetation removal filter was applied. The *n* values estimated for the main channels range from 0.040 to 0.045 and the *n* values estimated for the floodplain areas range from 0.050 to 0.065.

Step-backwater computations require a water-surface elevation as a boundary condition at either the downstream end of the stream reach for flows in the subcritical flow regime or at the upstream end of the reach for flows in the supercritical flow regime. Initial HEC-RAS simulations indicated that the flow in the stream reaches studied in Siguatepeque would be in the subcritical flow regime. Therefore, the boundary condition used was a water-surface elevation at cross section 0.294, the farthest downstream cross section in the Río Selguapa step-backwater model. This elevation, 1,065.14 meters, was estimated by a slope-conveyance computation assuming an energy gradient of 0.0016, which was estimated to be equal to the slope of the main channel bed. The computed water-surface elevations at the first few cross sections upstream may differ from the true elevations if the estimated boundary condition elevation is incorrect. However, if the error in the estimated boundary condition is not large, the computed profile asymptotically approaches the true profile within a few cross sections.

The step-backwater model provided estimates of water-surface elevations at all cross sections for the 50-year-flood discharges (tables 2-6 and figures 2-6).

The water-surface elevations at Río Celan bridge cross-section 0.676 and at Río Guique bridge cross-section 0.565 are above the low chord elevations of the bridges. Although the model did not indicate that these bridges would be overtopped, even a minor increase in flood elevations could cause floodwaters to overtop and possibly destroy these bridges. Also susceptible to possible overtopping and destruction is the Río Guique bridge at cross section 1.490, where the water-surface elevation is nearly as high as the low chord elevation of the bridge. Of the six bridges surveyed, the bridge most susceptible to failure from floodwaters is the Río Guique bridge at cross section 1.086. The estimated 50-year-flood water-surface elevation at this bridge overtops the bridge deck and road approaching the bridge by more than half a meter.

Table 2. Estimated water-surface elevations for the 50-year-flood on Río Selguapa at Siguatepeque, Honduras

[Peak flow for the 50-year flood is 323 cubic meters per second.**Cross-section stationing**: distance upstream from an arbitrary point near the model boundary; **Minimum channel elevation**, **Water-surface elevation**: elevations are referenced to the World Geodetic System Datum of 1984; **Abbreviations**: km, kilometers; m, meters; m/s, meters per second]

Cross-section stationing (km)	Minimum channel elevation (m)	Average velocity of flow (m/s)	Water-surface elevation (m)
2.886	1,063.36	2.32	1,070.47
2.774	1,063.96	3.11	1,069.87
2.561	1,062.75	3.64	1,068.78
2.226	1,062.09	1.82	1,068.26
2.018	1,062.04	2.61	1,067.71
1.836	1,061.62	2.82	1,067.11
1.700	1,060.02	2.00	1,066.88
1.339	1,059.49	2.12	1,066.45
0.927	1,058.81	2.02	1,065.97
0.688	1,057.94	1.78	1,065.76
0.467	1,057.82	1.98	1,065.45
0.294	1,057.38	2.39	1,065.14

Table 3. Estimated water-surface elevations for the 50-year-flood on Río Guique at Siguatepeque, Honduras

[Peak flow for the 50-year flood is 168 cubic meters per second.**Cross-section stationing**: distance upstream from an arbitrary point near the model boundary; **Minimum channel elevation**, **Water-surface elevation**: elevations are referenced to the World Geodetic System Datum of 1984; **Abbreviations**: km, kilometers; m, meters; m/s, meters per second]

Cross-section stationing (km)	Minimum channel elevation (m)	Average velocity of flow (m/s)	Water-surface elevation (m)
4.928	1,091.61	5.74	1,097.13
4.719	1,090.05	4.30	1,093.27
4.554	1,087.64	1.82	1,093.37
4.397	1,087.50	5.10	1,091.67
4.154	1,085.86	3.29	1,089.48
3.886	1,084.20	3.01	1,088.46
3.576	1,082.29	3.68	1,086.36
3.411	1,080.59	3.56	1,084.88
3.290	1,079.50	4.70	1,083.38
3.121	1,078.41	2.72	1,082.12
2.789	1,077.01	2.13	1,081.41
2.573	1,075.86	3.76	1,080.18
2.299	1,074.36	3.17	1,078.36
1.946	1,072.70	2.39	1,075.53
1.866	1,071.84	0.80	1,075.56
1.806	1,071.68	0.86	1,075.53
1.710	1,071.23	3.35	1,074.86
1.519	1,070.39	1.50	1,074.81
1.492	1,069.80	4.00	1,073.85
1.490 (bridge)			
1.484	1,069.80	4.79	1,073.34
1.468	1,069.99	2.18	1,073.98
1.362	1,069.42	2.13	1,073.70
1.255	1,069.04	1.51	1,073.50
1.108	1,069.03	1.51	1,073.27
1.088	1,067.80	0.59	1073.32
1.086 (bridge)			
1.076	1,067.80	0.73	1,072.70
1.043	1,068.35	1.27	1,072.57
0.581	1,066.92	2.57	1,071.32
0.567	1,066.54	1.90	1,071.41
0.565 (bridge)			
0.550	1,066.54	1.98	1,071.24
0.518	1,066.64	2.70	1,071.02
0.268	1,065.18	1.12	1,070.87
0.118	1,064.95	0.89	1,070.82
0.039	1,064.28	0.92	1,070.81

Table 4. Estimated water-surface elevations for the 50-year-flood on Río Celan at Siguatepeque, Honduras

[Peak flow for the 50-year flood is 161 cubic meters per second.**Cross-section stationing**: distance upstream from an arbitrary point near the model boundary; **Minimum channel elevation**, **Water-surface elevation**: elevations are referenced to the World Geodetic System Datum of 1984; **Abbreviations**: km, kilometers; m, meters; m/s, meters per second]

Cross-section stationing (km)	Minimum channel elevation (m)	Average velocity of flow (m/s)	Water-surface elevation (m)
3.711	1,081.11	2.01	1,084.40
3.575	1,081.18	1.35	1,083.87
3.490	1,079.58	2.45	1,082.98
3.415	1,078.75	1.55	1,082.54
3.270	1,077.95	1.71	1,081.67
3.151	1,077.45	1.68	1,080.64
3.090	1,075.90	1.01	1,080.30
2.996	1,075.70	1.19	1,079.90
2.918	1,075.19	1.13	1,079.59
2.777	1,076.33	0.93	1,079.30
2.637	1,074.97	1.70	1,078.83
2.495	1,075.36	1.04	1,078.64
2.374	1,073.45	2.37	1,078.07
2.169	1,072.85	2.57	1,077.36
1.960	1,072.51	1.12	1,077.14
1.798	1,071.71	1.03	1,076.91
1.632	1,071.83	1.61	1,076.23
1.520	1,071.43	1.04	1,076.02
1.369	1,071.10	0.96	1,075.87
1.215	1,071.09	0.65	1,075.77
1.059	1,071.46	1.53	1,075.38
0.834	1,071.30	1.24	1,074.45
0.699	1,070.54	0.99	1,074.31
0.678	1,069.33	2.88	1,073.84
0.676 (bridge)			
0.661	1,069.33	3.76	1,072.96
0.623	1,070.02	3.33	1,072.70
0.314	1,067.78	1.07	1,071.20
0.199	1,066.20	1.56	1,070.88
0.067	1064.24	1.00	1,070.85

Table 5. Estimated water-surface elevations for the 50-year-flood on Río Calan at Siguatepeque, Honduras

[Peak flow for the 50-year flood is 146 cubic meters per second.**Cross-section stationing**: distance upstream from confluence with Río Selguapa; **Minimum channel elevation**, **Water-surface elevation**: elevations are referenced to the World Geodetic System Datum of 1984; **Abbreviations**: km, kilometers; m, meters; m/s, meters per second]

Cross-section stationing (km)	Minimum channel elevation (m)	Average velocity of flow (m/s)	Water-surface elevation (m)
1.594	1,074.31	3.57	1,077.71
1.243	1,071.17	2.66	1,074.66
1.139	1,069.56	3.61	1,073.55
0.969	1,068.42	3.02	1,072.47
0.755	1,067.59	2.30	1,071.63
0.662	1,066.36	2.34	1,071.36
0.557	1,066.34	1.99	1,071.13
0.428	1,066.13	1.99	1,070.88
0.286	1,065.55	1.82	1,070.70

Table 6. Estimated water-surface elevations for the 50-year-flood on Quebrada Chalantuma at Siguatepeque, Honduras.

[Peak flow for the 50-year flood is 90 cubic meters per second.**Cross-section stationing**: distance upstream from confluence with Río Selguapa; **Minimum channel elevation**, **Water-surface elevation**: elevations are referenced to the World Geodetic System Datum of 1984; **Abbreviations**: km, kilometers; m, meters; m/s, meters per second]

Cross-section stationing (km)	Minimum channel elevation (m)	Average velocity of flow (m/s)	Water-surface elevation (m)
1.631	1,078.81	2.99	1,081.85
1.494	1,077.38	3.72	1,079.86
1.364	1,074.84	1.43	1,078.32
1.247	1,073.92	1.46	1,078.13
1.220	1,074.60	3.44	1,077.51
1.217 (bridge)			
1.205	1,074.60	4.44	1,076.92
1.198	1,072.33	2.47	1,076.89
1.145	1,072.63	2.58	1,076.58
1.119	1,072.60	3.38	1,076.13
1.117 (bridge)			
1.106	1,072.60	4.37	1,075.55
1.098	1,071.80	2.26	1,075.71
1.021	1,071.58	2.38	1,075.30
0.879	1,069.96	4.31	1,073.07
0.680	1,068.44	2.15	1,071.91
0.561	1,067.83	2.25	1,071.39
0.429	1,066.85	1.86	1,070.91
0.123	1,065.06	0.42	1,070.91

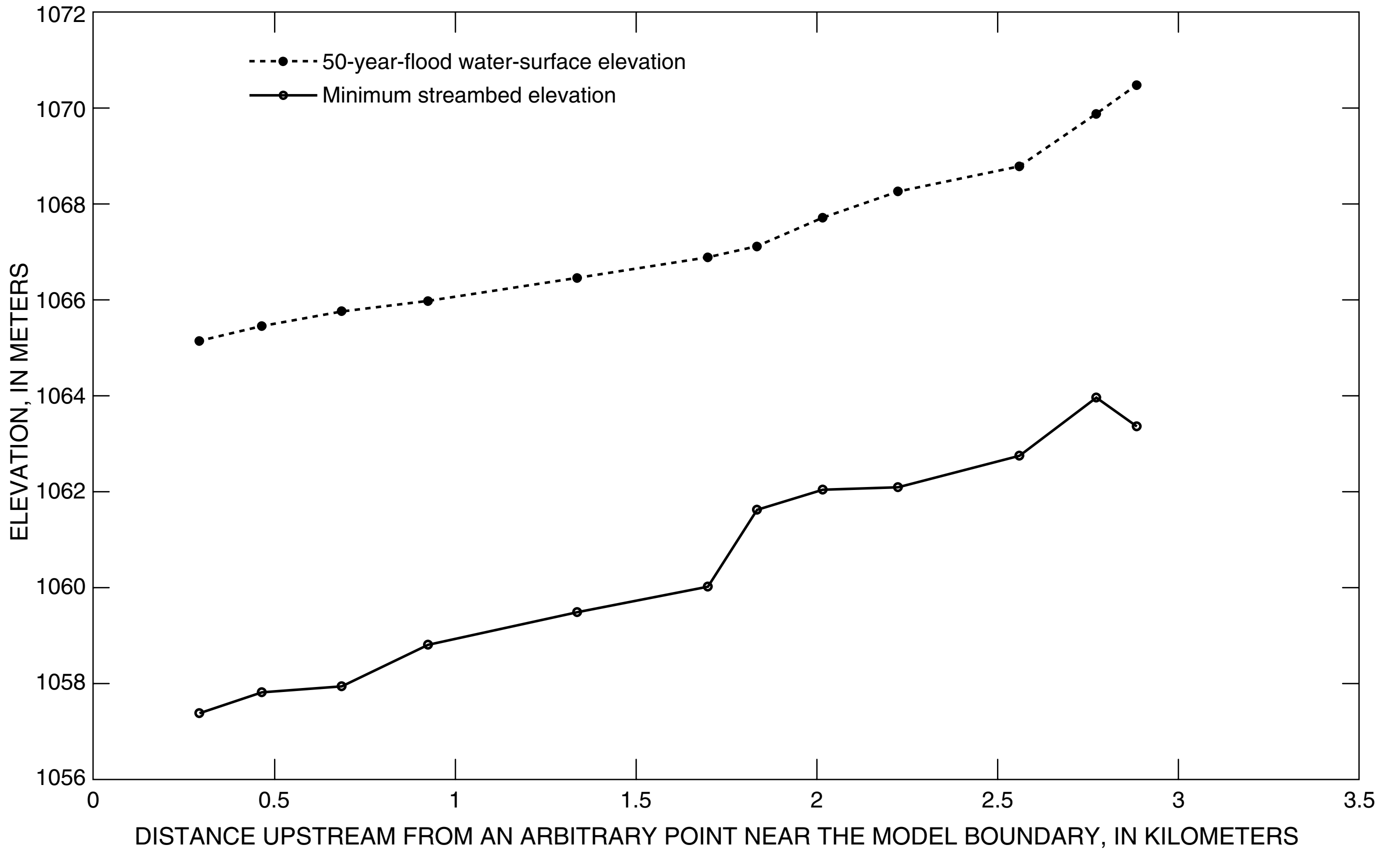

Figure 2. Water-surface profile, estimated using the step-backwater model HEC-RAS, for the 50-year flood on Río Selguapa at Siguatepeque, Honduras.

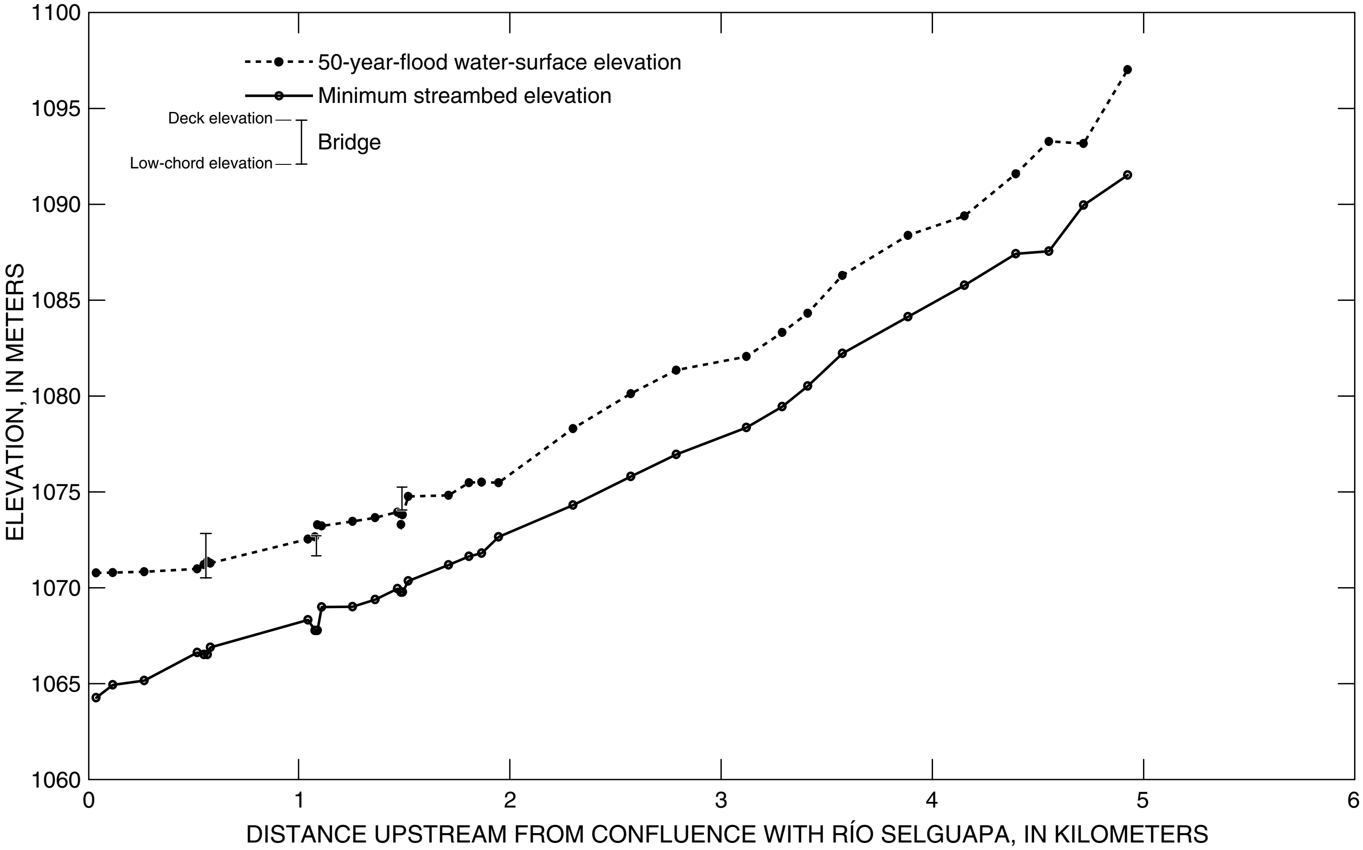

Figure 3. Water-surface profile, estimated using the step-backwater model HEC-RAS, for the 50-year flood on Río Guique at Siguatepeque, Honduras.

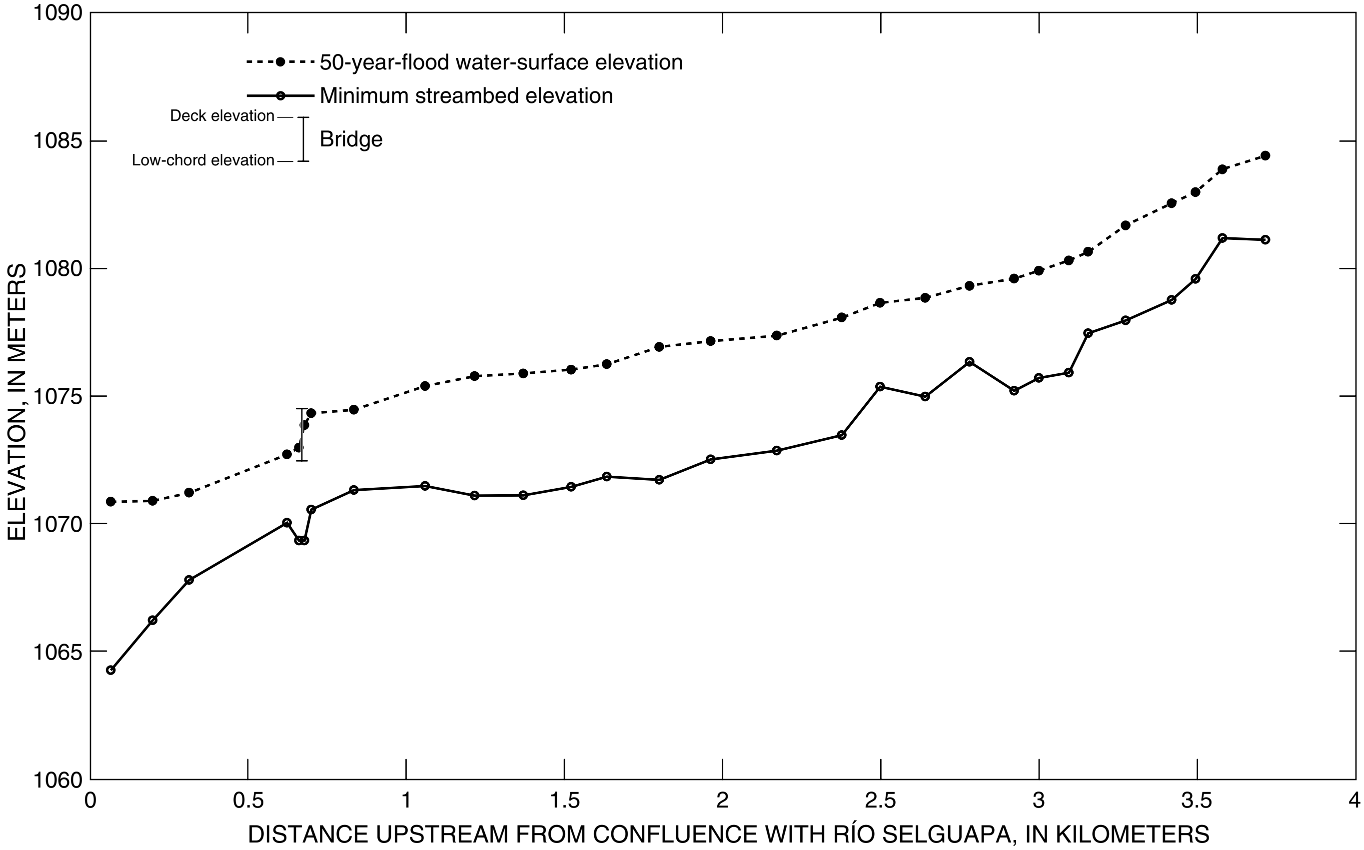

Figure 4. Water-surface profile, estimated using the step-backwater model HEC-RAS, for the 50-year flood on Río Celan at Siguatepeque, Honduras.

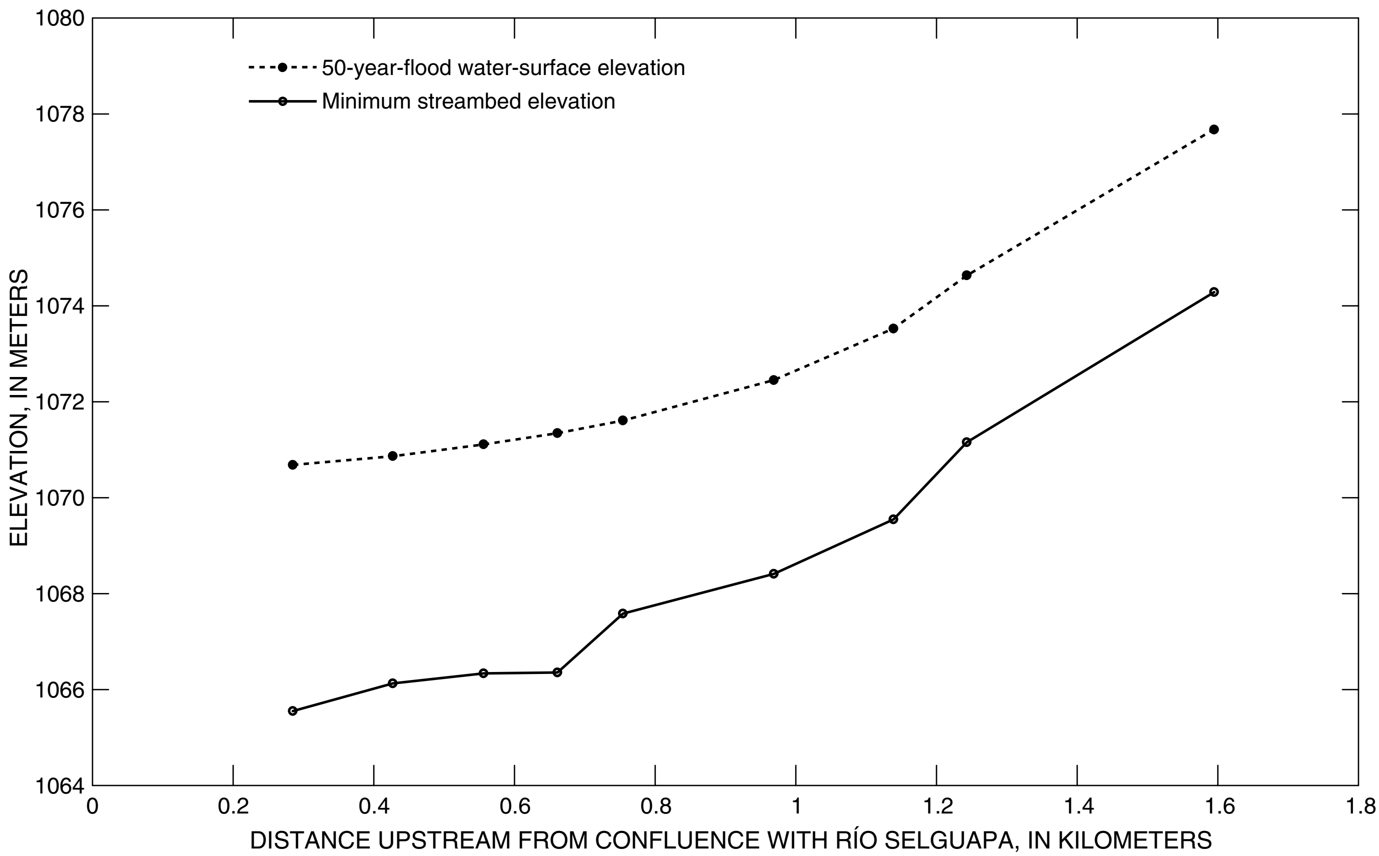

Figure 5. Water-surface profile, estimated using the step-backwater model HEC-RAS, for the 50-year flood on Río Calan at Siguatepeque, Honduras.

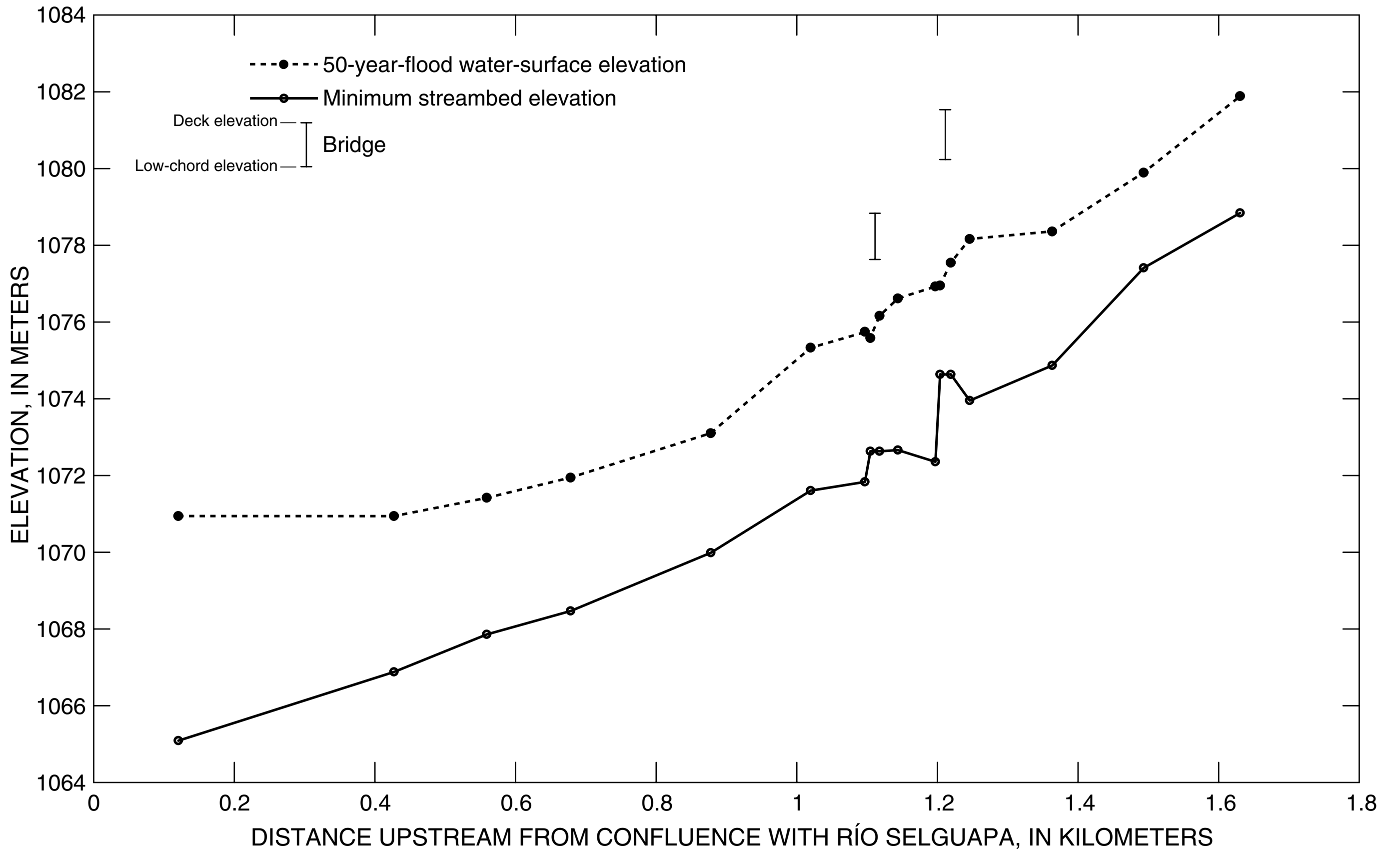

Figure 6. Water-surface profile, estimated using the step-backwater model HEC-RAS, for the 50-year flood on Quebrada Chalantuma at Siguatepeque, Honduras.

FIFTY-YEAR FLOOD-INUNDATION MAPS

The results from the step-backwater hydraulic model were processed by the computer program HEC-GeoRAS to create GIS coverages of the area and depth of inundation for the study area. The GIS coverage of area of inundation was created by intersecting the computed water-surface elevations with the topographic TIN that was produced from the LIDAR data. This coverage was then overlain on an existing 1:50,000 topographic digital raster graphics map (figure 1) produced by the U.S. National Imagery and Mapping Agency (Gary Fairgrieve, USGS, written commun., 1999). Depth of inundation at Siguatepeque for 50-year-floods on the streams studied (figure 7) was computed by subtracting the topographic TIN from a computed water-surface elevation TIN to produce a grid with a cell size of 2 meters.

There is an area of dense vegetation along the left-bank floodplain (looking downstream) of Río Celan located approximately between cross-sections 2.777 and 2.996 that on figures 1 and 7 appears to not be inundated, even though it is surrounded by inundated areas. This area actually would be inundated by a 50-year flood. The reason for the discrepancy is that the LIDAR filter used to remove vegetation did not effectively remove the dense vegetation in this area. Consequently, the top of the vegetation, which is higher than the 50-year-flood elevations, was the data being used in the topographic TIN to determine flood inundation and flood depths in the area.

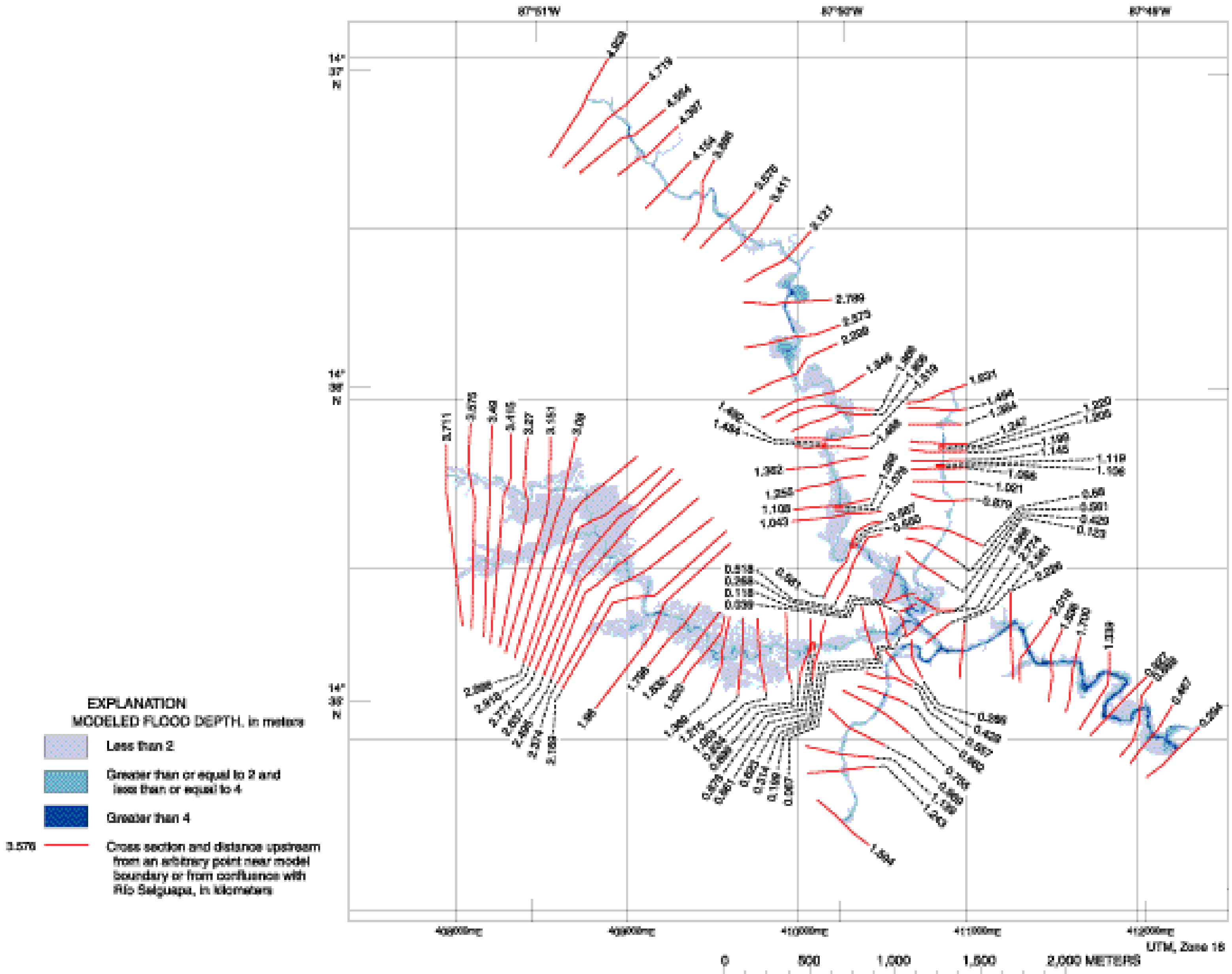

Figure 7. Depth of inundation for the 50-year flood and location of cross sections on Río Selguapa, Río Guique, Río Celan, Río Calan, and Quebrada Chalantuma at Siguatepeque, Honduras.

The blue lines depicting the river channels on the digital raster graphics map used as the base map for figure 1 lie outside the 50-year-flood boundaries at some locations. This probably results from changes in the river courses as a result of flood flows that occurred after the map was created, especially those that resulted from Hurricane Mitch.

The flood-hazard maps are intended to provide a basic tool for planning or for engineering projects in or near the floodplains of the rivers studied. This tool can reasonably separate high-hazard areas from low-hazard areas in the floodplains to minimize future flood losses. However, significant introduced or natural changes in main-channel or floodplain geometry or location can affect the area and depth of inundation. Also, encroachment into the floodplains with structures or fill will reduce flood-carrying capacity and thereby increase the potential height of floodwaters, and may also increase the area of inundation.

DATA AVAILABILITY

GIS coverages of flood inundation and flood depths shown on the maps in figures 1 and 7 are available in the Municipal GIS project, a concurrent USAID-sponsored USGS project that will integrate maps, orthorectified aerial photography, and other available natural resource data for a particular municipality into a common geographic database. The GIS project, which is located on a computer in the Siguatepeque municipality office, allows users to view the GIS coverages in much more detail than shown on figures 1 and 7. The GIS project will also allow users to overlay other GIS coverages over the inundation and flood-depth boundaries to further facilitate planning and engineering. Additional information about the Municipal GIS project is available on the Internet at the GIS Products Web page (http://mitchnts1.cr.usgs.gov/projects/gis.html), a part of the USGS Hurricane Mitch Program Web site.

The GIS coverages and the HEC-RAS model files for this study are available on the Internet at the Flood Hazard Mapping Web page (http://mitchnts1.cr.usgs.gov/projects/floodhazard.html), which is also a part of the USGS Hurricane Mitch Program Web site.

REFERENCES CITED

Mastin, M.C., 2002, Flood-hazard mapping in Honduras in response to Hurricane Mitch: U.S. Geological Survey Water-Resources Investigations Report 01-4277, 46 p.

Morales-Canales, José, ed., 1997-1998, Atlas geográfico de Honduras: Tegucigalpa, Honduras, Ediciones Ramsés, 48 p.

Rappaport, E.N., and Fernandez-Partagas, José, 1997, The Deadliest Atlantic Tropical Cyclones, 1492-Present: Miami, Florida, NOAA, National Hurricane Center, Tropical Prediction Center, technical memorandum, on-line on the World Wide Web from URL http://www.nhc.noaa.gov/pastdeadly.html, accessed September 21, 2001, HTML format.

U.S. Army Corps of Engineers, 1998, HEC-RAS, River Analysis System user's manual: Davis, California, Hydrologic Engineering Center, 320 p.

———2000, HEC-GeoRAS, An extension for support of HEC-RAS using ArcView user's manual: Davis, California, Hydrologic Engineering Center, 96 p.

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